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PATENT APPLICATION #4

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	)	
	:	Examiner: NYA
CAMERON B. BROWNE	)	
	:	Group Art Unit: NYA
Application No.: 09/277,171	)	
	:	
Filed: March 26, 1999	)	
	:	
For: OPACITY BASED INTERFERENCE TEXTURE	) :	April 29, 1999

Assistant Commissioner for Patents
Washington, D.C. 20231

CLAIM TO PRIORITY

Sir:

Applicant hereby claims priority under the International Convention and all rights to which he is entitled under 35 U.S.C. § 119 based upon the following Australian Priority Application:

No. PP2650 filed March 27, 1998

A certified copy of the priority document is enclosed.

Applicants' undersigned attorney may be reached in our New York office by telephone at (212) 218-2100. All correspondence should continue to be directed to our address given below.

Respectfully submitted,

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09/277,171

AUSTRALIA

Patent Office
Canberra

I, KIM MARSHALL, MANAGER EXAMINATION SUPPORT AND SALES, hereby certify that the annexed is a true copy of the Provisional specification in connection with Application No. PP 2650 for a patent by CANON KABUSHIKI KAISHA filed on 27 March 1998.

WITNESS my hand this Twenty-ninth day of March 1999

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KIM MARSHALL
<u>MANAGER EXAMINATION SUPPORT AND SALES</u>

S & F Ref: 411516

ORIGINAL

AUSTRALIA

Patents Act 1990

PROVISIONAL SPECIFICATION FOR THE INVENTION ENTITLED:

Opacity Based Colour Interference Texture

Name and Address
of Applicant: Canon Kabushiki Kaisha, incorporated in Japan, of 30-2, Shimomaruko 3-chome, Ohta-ku, Tokyo, JAPAN

This invention is best described in the following statement:

5805

Opacity Based Colour Interference Texture

The present invention relates to a method of generating a coloured or shaded texture to be displayed on a display device or printer.

The invention has been developed primarily for use in generating background effects for displayed or printed matter. However, it will be appreciated that the textures generated may be applied to any suitable subject, including sprites, lettering, and the surfaces of three-dimensional representations.

A number of prior art systems have been developed to generate various types of textures. Typically, these systems involve modulation of existing functions, such as Perlin noise functions, reaction-diffusion or vector fields. Alternatively, an existing image may be modulated using these or similar functions. However, such approaches tend to be relatively processor intensive, which may be a disadvantage where speed is important.

There is an ongoing interest in generating visually interesting textures in a relatively simple, fast manner, for use with all types of text and graphics manipulation and display.

The present invention provides a method of generating a coloured or shaded texture for images to be displayed on a display device or printed, the method including the steps of:

(a) providing a plurality of shape elements, each shape element defining a surface;

(b) providing each of the shape elements with an opacity which varies over its surface;

(c) arranging the shape elements in a overlapping fashion; and

(d) rendering the shape elements for output to a printer or display device, such that the overlapping opacities generate a coloured or shaded texture.

Preferably the shape elements are regular geometric shapes, and are all of the same general shape. It is also preferred that the shape elements be of a similar size. In a particularly preferred embodiment, the shape elements are circles.

Other aspects of the invention are described in the following detailed description, and in the numbered paragraphs at the end of this document.

A preferred embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a surface plot showing opacity values across a unit square region, determined from a circle centred at one corner with opacity varying from 1 at its centre to 0 at its perimeter;

Figure 2 is a surface plot similar to that in Figure 1, determined from two circles centred at adjacent corners;

Figure 3 is a surface plot similar to that shown in Figures 1 and 2, determined from three circles centred at three corners;

Figure 4 is a surface plot similar to that shown in Figures 1, 2, and 3, determined from four circles centred at the corners;

Figure 5 shows a surface plot of opacity values across a unit square region in which the focus is 0;

Figure 6 shows a surface plot similar to that shown in Figure 5, in which the focus is 0.5;

Figure 7 shows a shaded texture overlayed with a flat shaded letter "L" (designated 21), generated in accordance with the method of the invention;

Figure 8 is a shaded texture similar to that shown in Figure 7, with the overlapping circles rendered using a OVER operator;

Figure 9 is a shaded texture similar to that shown in Figure 8, with a focus of 0.95;

Figure 10 is a shaded texture similar to that shown in Figures 8 and 9, with a focus of 1.5, and with the opacities rendered using a PLUS DOUBLE operator;

Figure 11 is a shaded texture similar to that shown in Figures 8 to 10, in which opacity varies from 0.75 at the focal point to 0.25 at the perimeters, and

Figure 12 is a shaded texture similar to that shown in Figures 8 to 11, in which opacity varies from 0.25 at the focal point to 0.75 at the perimeters.

Referring to the drawings, the invention provides a method of generating a coloured or shaded texture for images to be displayed on a display device or printer. In its simplest form, the invention includes the steps of:

(a) providing a plurality of shape elements, each shape element defining a surface;

(b) providing each of the shape elements with an opacity which varies over its surface;

(c) arranging the shape elements in an overlapping fashion; and

(d) rendering the shape elements for output to a printer or a display device, such that the overlapping opacites generate a coloured or shaded texture.

In the preferred, coloured embodiments, a coloured texture is generated by means of interference in colour space when overlapping shapes of varying opacity are composited. In this way, the resultant texture is effectively encoded in the colour (or shade) and opacity of the shapes, and is not realised until rendering.

The method requires that a plurality of overlapping shapes be provided, thereby to ensure the requisite interference. Typically, the shape elements are regular geometric shapes, and will usually be of uniform size and shape. However, different sizes and shapes may be mixed to provide varying visually interesting textures.

As shown in the various figures, it is particularly desirable that the shape elements be circles, although other shape elements such as squares, hexagons or other regular polygons (not shown) may be used to provide different textures.

Each shape has associated with it a focal point 1 defined relative to its perimeter. As shown in Figures 5 and 6, maximum opacity usually occurs at the focal point 1, and decreases towards a perimeter 2 of the circle. Opacity is shown on a vertical scale 4. As shown in Figure 6, moving the focal point 1 towards the perimeter 2 skews the opacity with relation to the unit square, which, when composited with other shape elements, causes different visually interesting textures to be generated.

The opacity of each shape may vary between its focal point 1 and perimeter 2 according to any suitable function, although linear interpolation is used in the preferred embodiments. The use of linear interpolation helps to ensure a relatively consistent opacity value across the final texture.

Consistency of the opacity is also improved when the shapes are relatively evenly distributed across the texture region, and is of particular importance if the texture is to be used for further compositing operations. Figures 1 to 4 show the effects of overlying

opacities of neighbouring circles, each having a focus of 0. In Figure 1, a circle 6 (only one quarter of which is shown) disposed in the horizontal plane and centred at a first corner 8 of a unit square 10 exhibits a relatively steep opacity gradient 12. Figure 2 adds a circle to an adjacent corner, 14, thereby reducing the overall opacity differential across the unit square as a whole. Figure 3 adds yet another circle, whilst Figure 4 adds a final circle to the last free corner of the unit square 10. As shown in Figure 4, the effect of multiple overlapping circles having relatively constant spacing and linear opacity gradients tends to produce a relatively constant opacity across the area in which the circles are disposed. There are, in this case, some minor "bumps" associated with the adding of the overlapping circles. However, these do not depart greatly from an opacity of 1. For example, a central bump 16 with an opacity of about 1.2 is the furthest deviation from an opacity of 1.0 across the whole unit square. An algorithm such as mesh fitting may be used to generate reasonably equidistance points at which to place the shape elements.

A focus parameter dictates the relationship of the focal point 1 to its associated perimeter 2; in a preferred embodiment, a default value of 0 indicates that the focal point 1 is at the circle's centre, as shown in Figure 5, whilst a value of 1 indicates that the focal point 1 is on the perimeter of the circle. Figure 6 shows the case where the focal point 1 is shifted 0.25 units towards the perimeter 2.

In the preferred form, the available focus parameter values vary between the centre of the circle and the perimeter 2, although other embodiments extend beyond this range to allow focal points outside the perimeter 2. Varying the focus parameter results in colour and opacity discontinuities which can give an impression of substantial shape not offered by other texture-generation algorithms. For example, in Figure 9 there are shown discontinuities 18 in brightness as the colours and opacities "wrap" around. This occurs as composited opacities which exceed a predetermined maximum opacity respectively are remapped to a lower opacity. An analogous colour "wrapping" takes place as colours are composited in combination with varying opacities. For focal points 1 which exceed a focus parameter of 1.0, this "wrapping" can become more noticeable, as shown in Figure 10. The sharp black-white discontinuities 20 are examples of this. In Figures 7 to 10,

there appear regions of gradually changing shade 22, which imply solidity or three-dimensionality.

The colour of each component shape is independent of the opacity function used, and may be a flat colour, a colour blend, or even a shade. Flat colour is preferred due to ease of implementation, although other visually interesting patterns may be achieved by varying the colours of the various shape elements. Various compositing operators may be used to calculate overlapping shape opacity, and include those typically used in computer graphics, such as: OVER (Figures 8 and 12), XOR, PLUSC (Figures 7, 9, 11), and PLUSW (Figure 10). The PLUSW operator is of particular interest, because it introduces colour discontinuity resulting from colour wrapping without introducing opacity discontinuities. This is why the texture in Figure 10 appears smoother, as shown in region 23, without the opacity discontinuities introduced by other operators.

Referring to Figure 11, there is shown a texture generated by the method of the invention, whereby the opacity at the focal point is 0.75, and the opacity of the perimeter is 0.25. This results in definite opacity discontinuities 24 at the edges of circles, because the opacity of each circle does not taper to 0 at the perimeter. Figure 12 illustrates a similar arrangement, in which the opacity is 0.75 at the perimeter and 0.25 at the focal point, composited using an OVER operator. The relatively high opacity at the edge of each circle generates even more distinct opacity discontinuities 26 than are shown in Figure 11. These examples demonstrate the quite different effects which can be generated by altering a relatively small number of parameters.

The colour space in which the overlapping shapes are rendered has a direct bearing on the resultant texture. LAB, a colour space based on the human eye's sensitivity to colour, is the preferred choice of colour space, as it results in colours combining in a non-intuitive way to produce visually interesting results. However, the method will work for other colour spaces commonly used in computer graphics, such as RGB or CMY, and may give visually different results for each.

Varying any of the many perimeters of the shape elements will correspondingly vary the resultant texture. Accordingly, the size of the shape elements, the geometric shapes represented, the density of the shape elements, the opacities and opacity gradients

as well as the colour space and compositing operators, may be selected and altered at will be generate interesting textures.

A major advantage of the present invention is that the generated textures do not rely upon modulation of existing functions, such as Perlin noise functions, reaction-diffusion, or vector fields. Furthermore, source images for use with such modulation are not required, which results in the method requiring relatively little in the way of memory or processor resources when implemented on a computer system. As well as the visually interesting results obtainable by the invention, the potential reduction in computer resources provides an additional advantage over prior art coloured or shaded texture generation schemes.

Although the invention has been described with reference to a number of specific examples, it will be appreciated by those skilled in the art that the invention may be embodied in many other forms.

Various aspects of the invention are described in the following numbered paragraphs:

1. A method of generating a coloured or shaded texture for images to be displayed on a display device or printed, the method including the steps of:

(a) providing a plurality of shape elements, each shape element defining a surface;

(b) providing each of the shape elements with an opacity which varies over its surface;

(c) arranging the shape elements in an overlapping fashion; and

(d) rendering the shade elements for output to a printer or display device, such that the overlapping opacities generate a coloured or shaded texture.

2. A method according to paragraph 1, wherein the shape elements are regular geometric shapes.

3. A method according to paragraph 2, wherein each of the shape elements is of the same general shape.

4. A method according to paragraph 2 or 3, wherein the shape elements are of a similar size.

5. A method according to any one of the preceding paragraphs, wherein the shape elements are circles.

6. A method according to any one of paragraphs 1 to 4, wherein the shape elements include squares, hexagons, or other regular polygons.

7. A method according to any one of the preceding paragraphs, further including the step of assigning a focal point to each of the shape elements, wherein the opacity of each shape varies with distance from the focal point.

8. A method according to paragraph 7, wherein each focal point is located within its associated shape element.

9. A method according to paragraph 8, wherein each focal point is located at or adjacent a centre of its associated shape element.

10. A method according to any one of paragraphs 7 to 9, wherein the opacity at any given point within each shape element is determined by the distance of that point from the focal point.

11. A method according to paragraph 7, wherein opacity of each shape element varies between the focal point and the perimeter of the shape element in accordance with a predetermined function.

12. A method according to paragraph 10, wherein the predetermined function is exponential or linear.

13. A method according to any one of the preceding paragraphs, wherein at least some of the shape elements have a colour component associated with them.

14. A method according to paragraph 13, wherein the colour components vary from shape element to shape element.

15. A method according to paragraph 13 or paragraph 14, wherein the colour component of each shape element varies across its surface.

16. A method according to any one of paragraphs 13 to 15, further including the step of varying the colour components of the shape elements over time, and periodically rendering the shape elements.

17. A method according to paragraph 16, wherein the colour components are varied in a cyclic fashion.

18. A method according to paragraph 17, wherein a period associated with the cyclic colour change is selected at random for each shape element.

19. A method according to any one of the preceding paragraphs, further including the step of varying the opacity of one or more of the shape elements over time, and periodically rendering the shape elements.

20. A method according to paragraph 16, wherein the opacity is varied in a cyclic fashion.

21. A method according to paragraph 17, wherein a period associated with the cyclic opacity change is selected at random for each shape element.

22. A coloured or shaded texture generated according to any one of the preceding paragraphs, and printed or otherwise applied to paper, card or other reproduction medium.

DATED this Twenty Seventh Day of March 1998

Canon Kabushiki Kaisha

Patent Attorneys for the Applicant

SPRUSON & FERGUSON

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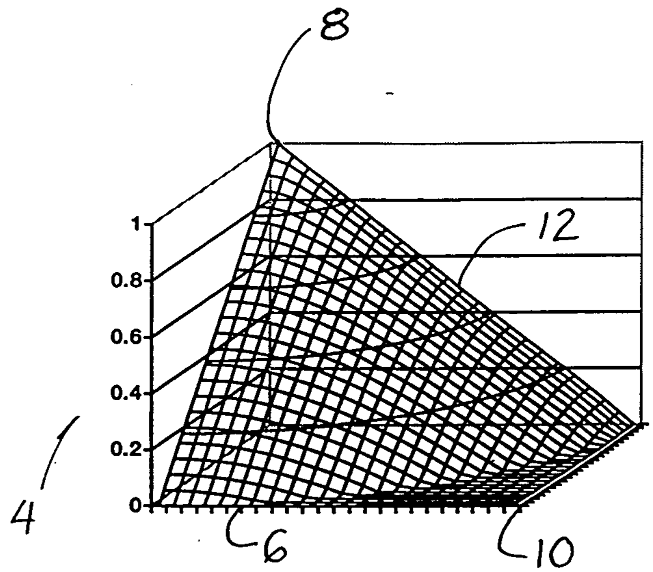

FIGURE 1

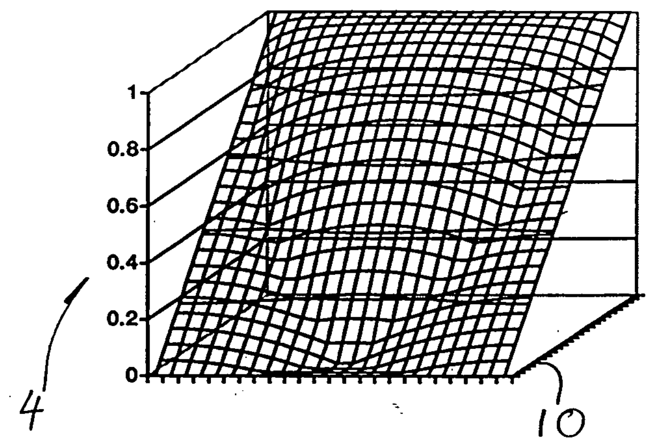

FIGURE 2

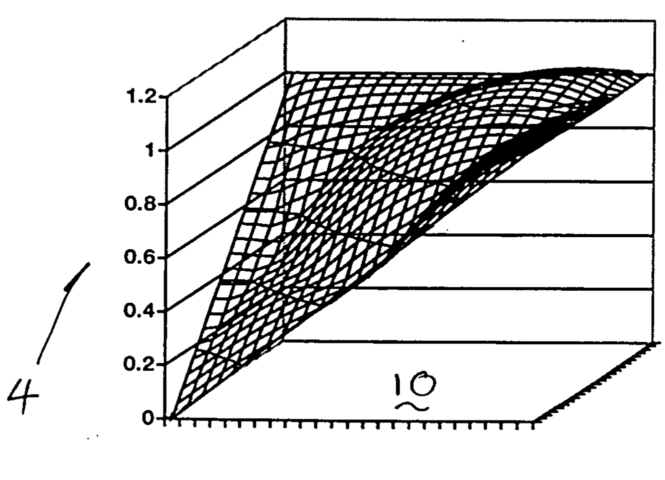

FIGURE 3

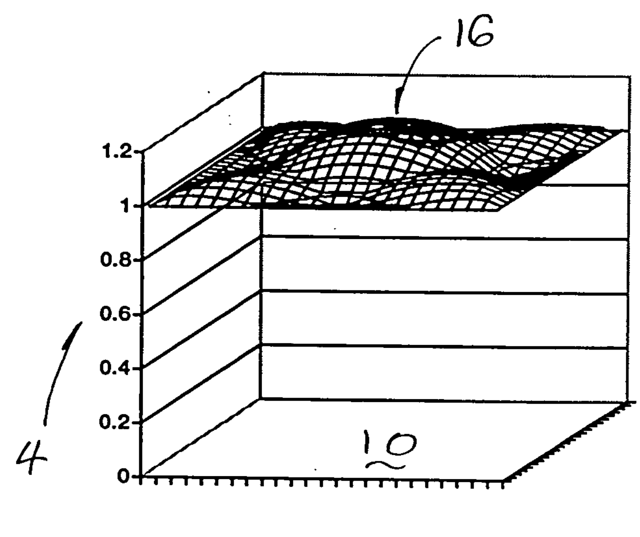

FIGURE 4

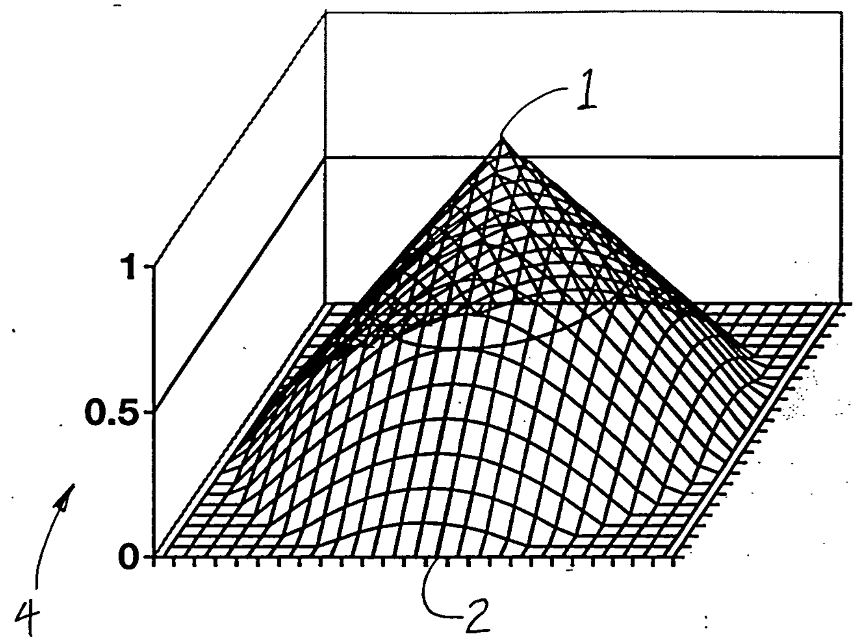

FIGURE 5

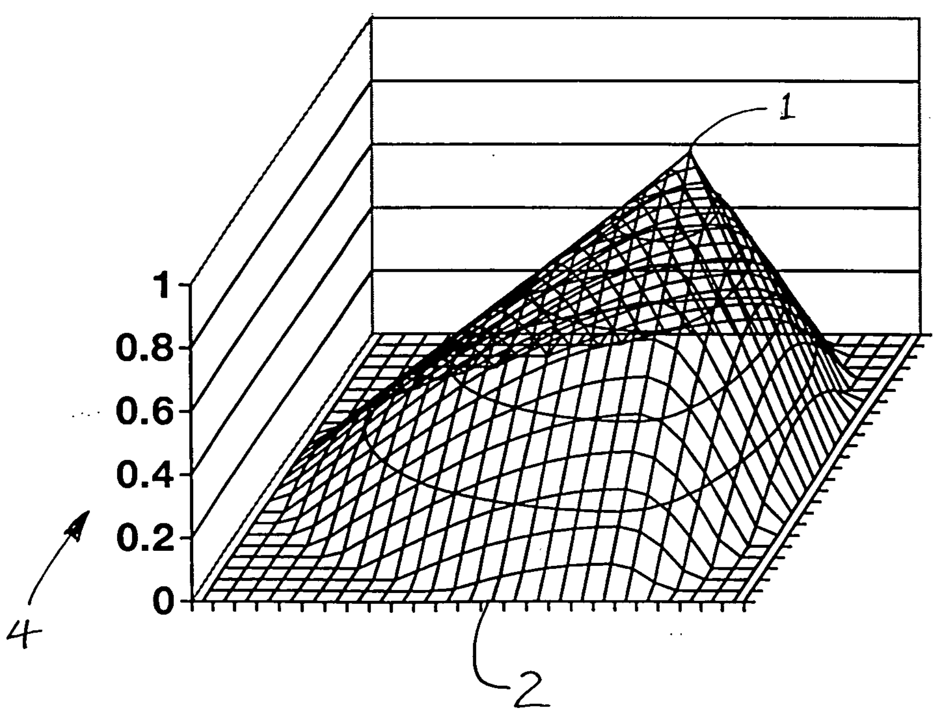

FIGURE 6

Figure 7

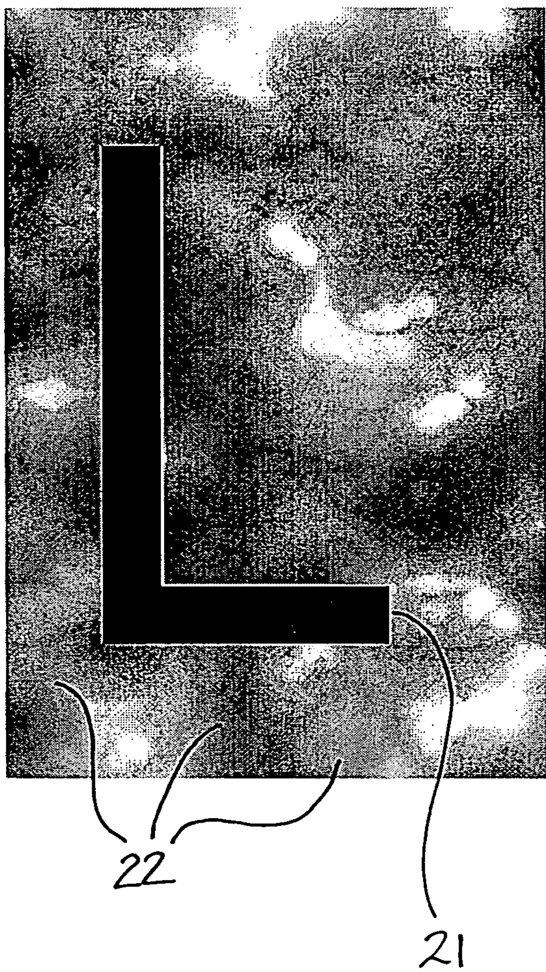

Figure 8

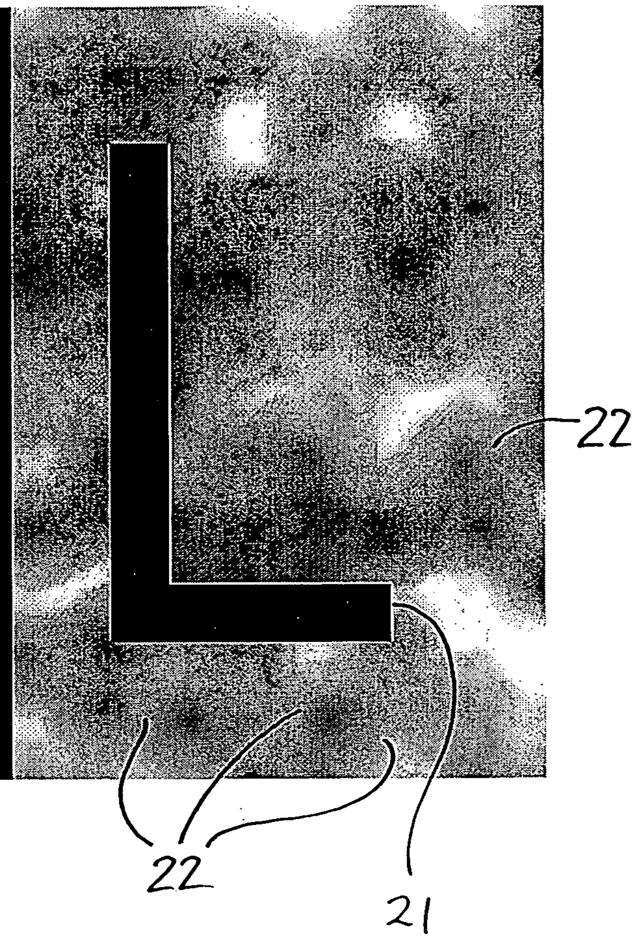

Figure 9

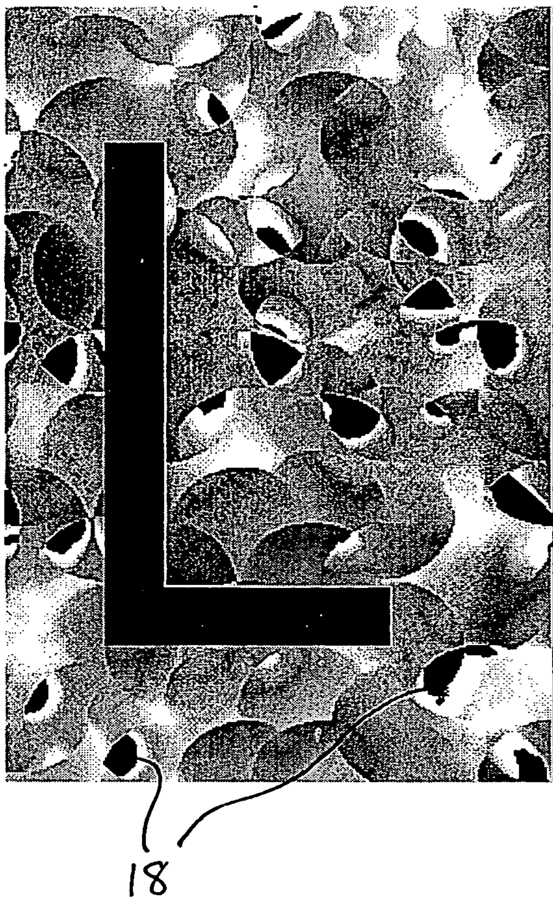

Figure 10

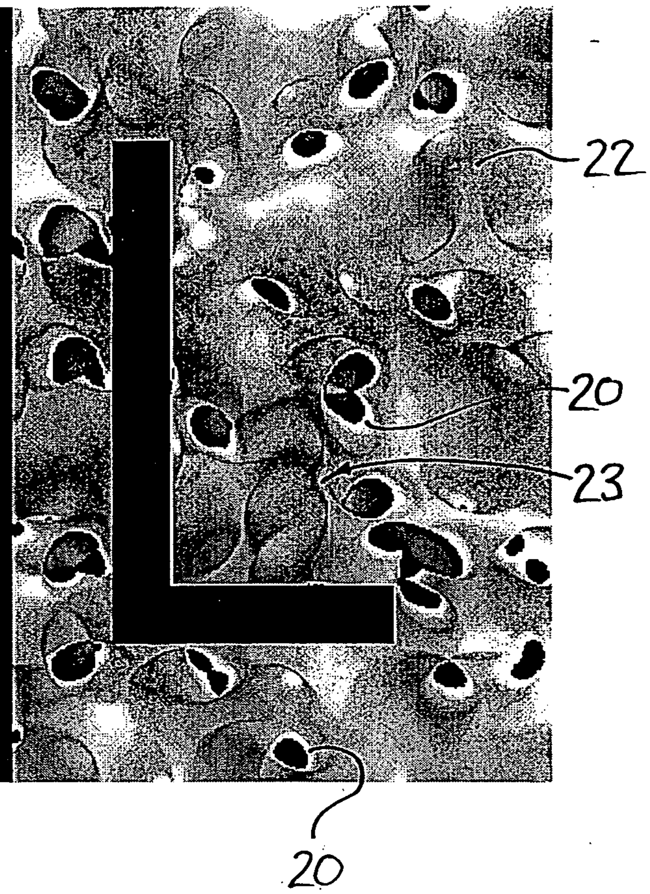

Figure 11

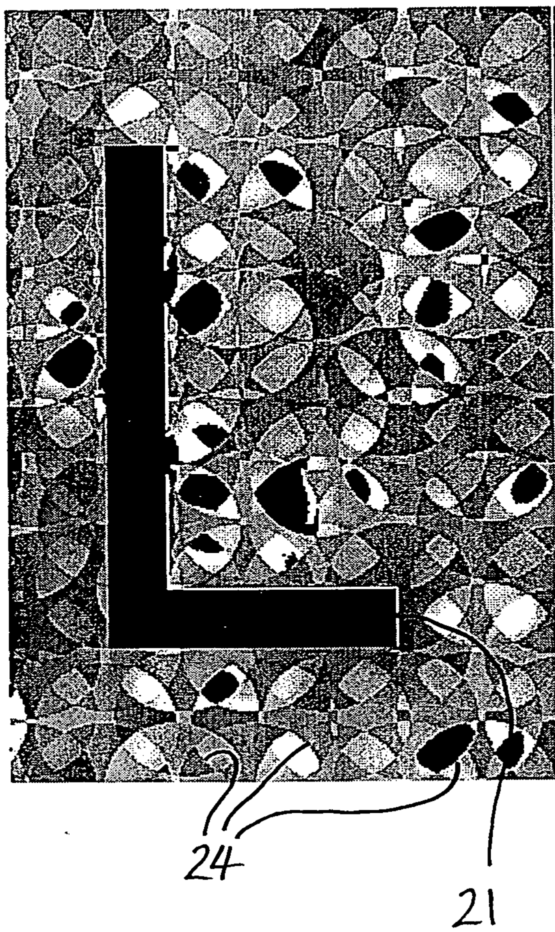

Figure 12